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AUTHOR	Mennecke, Brian E.
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ABSTRACT

Geographic information systems (GIS) are increasing in importance as a resource for collecting, managing, and analyzing data pertaining to a variety of business problems. Yet, the number of business schools that have incorporated GIS as a significant part of even one of their core business courses is quite small. Thus, little is known about how to teach GIS in business courses and how business students respond to being taught about this subject. To examine these issues, GIS training was included as a significant part of a decision support systems course offered within a traditional business school curriculum at East Carolina University (North Carolina). Attitudes and opinions of students concerning the role of GIS in business were collected both prior to and after students were given training on GIS in the course. Results indicate that students' attitudes about the effectiveness of GIS as a decision support tool and its role in business courses improved after their exposure to the technology. However, the results also showed that students did not develop more positive perceptions about the benefit of GIS training on their careers. The paper also discusses some of the instructors' observations related to teaching GIS in business school courses. (Author/MES)

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TEACHING SPATIAL ANALYSIS IN BUSINESS: THE CASE OF GEOGRAPHIC INFORMATION SYSTEMS IN A DECISION SUPPORT SYSTEMS COURSE

Brian E. Mennecke
East Carolina University

Geographic information systems (GIS) are increasing in importance as a resource for collecting, managing, and analyzing data pertaining to a variety of business problems. Yet, the number of business schools that have incorporated GIS as a significant part of even one of their core business courses is quite small. Thus, little is known about how to teach GIS in business courses and how business students respond to being taught about this subject. To examine these issues, GIS training was included as a significant part of a decision support systems course offered within a traditional business school curriculum. Attitudes and opinions of students concerning the role of GIS in business were collected both prior to and after students were given training on GIS in the course. Results indicate that students' attitudes about the effectiveness of GIS as a decision support tool and it role in business courses improved after their exposure to the technology. However, the results also showed that students did not develop more positive perceptions about the benefit of GIS training on their careers. The paper also discusses some of the instructors observations related to teaching GIS in business school courses.

INTRODUCTION

Geographic information systems (GIS) provide both database management and decision support capabilities that offer users a powerful set of tools for solving a variety of mission critical tasks and problems (Fung & Remsen, 1997; Mennecke, 1997; Wofford & Thrall, 1997). GIS have been successfully used for many years by decision makers in public planning and administration and in a variety of government agencies and bureaus (Brudney & Brown, 1992; Grupe, 1992; Worrall, 1994). Over the last few years GIS has also begun to be used extensively by business organizations in a variety of industries (Mennecke, Dangermond, Santoro, & Darling, 1998; Francica, 1998). Because many decisions include geographic concepts (e.g., the location of infrastructure, customers, labor, natural resources, or transportation assets), these systems can be particularly useful in helping to implement tactics and perform strategic planning.

There is little doubt that GIS is an important technology for business, but does this mean that it should be taught in business school courses? Unfortunately, the jury is still out regarding this question. For example, the traditional place where geographic concepts and techniques are taught is in geography departments. Yet many, if not most, geographers are ill equipped to teach business concepts and applications (Mennecke, 1997).

Where then does this leave us? Who should be teaching concepts related to GIS applications for business? This is a question that is being asked more frequently by academics and users alike. For example, a round table discussion on the issue of teaching GIS as a business tool was conducted recently at the Business Geographics for Educators and Researchers conference (June, 1997; Atlanta Georgia). Leading representatives from academia and industry participated. Although a variety of opinions were voiced, many participants agreed on two issues:

1. The principles of geography, cartography, and other technical mapping concepts should be taught by those who have the best understanding of these issues: Geographers.

2. However, because GIS is a tool that can be and is being used by business, there is an important role for business schools in teaching GIS in a number of areas.

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In this context, GIS should be taught in like manner to the way that spreadsheet and database software is taught to business students: as a problem-solving tool. As such, students who are taught GIS should be taught those principles and concepts related to the technology that enables them to be intelligent users. This concept is similar to the way GIS is taught in many other disciplines such as political science, public planning, archeology, and geology. Students in these disciplines often take only one or, at most, two course covering GIS applications so that they learn enough about the technology to utilize it effectively and correctly.

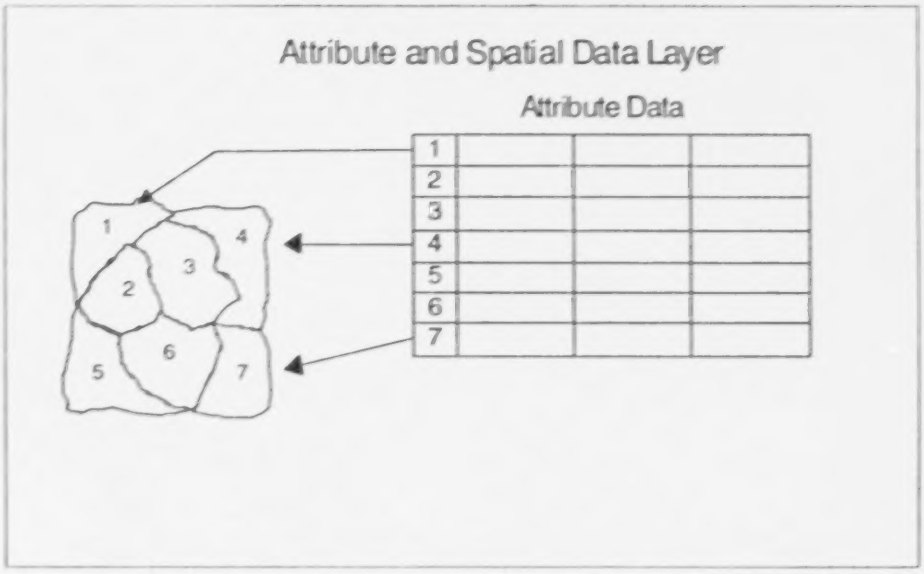
However, if GIS is to be taught to business students it is important to know how they will respond to this experience. Therefore the purpose of this paper is to examine student perceptions about the role of GIS in business school courses and the implications of these attitudes for teaching this topic. To examine this issue, we conducted a research study to identify student attitudes about the effectiveness of GIS, its potential impact on their career, and their opinion about the role of GIS in business school courses. The next section provides background information about GIS and GIS education. Next, the research methodology used to conduct this study is presented. Following this, the results are discussed. Finally, the paper concludes with a discussion of the findings and implications for education and future research.

BACKGROUND AND LITERATURE REVIEW

What Is GIS?

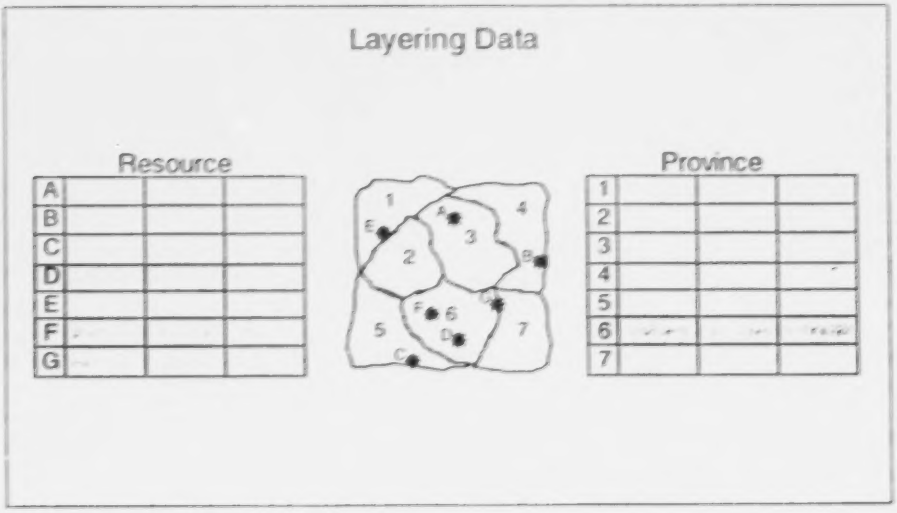
GIS are a type of relational database management system that can be used to store attribute data about entities as well as information about the spatial location of features associated with table entries. Figure 1 illustrates how each table entry (shown on the right) is linked to a feature on the map. The spatial data is stored by recording both the coordinates of the spatial features as well as data that identifies the features. The unique capability of GIS software relates to the ability of the GIS database engine to integrate the spatial and attribute data. For example, if a GIS layer has a field for county name and an attribute table in another database also has a field for county name, a join can be constructed between the two data sets. As a result, GIS data can easily be integrated with data derived from other database environments. This means that users are enabled to integrate GIS functionality with data that reside in other organizational information systems.

FIGURE 1
THE RELATIONSHIP BETWEEN ATTRIBUTE AND SPATIAL DATA FOR A SPATIAL DATA LAYER (I. E., SPATIAL COVERAGE)



One of the most powerful capabilities of GIS is their ability to display the spatial location of records on a map thus enabling the user to visualize the relationship between objects of interest. This visualization capability is important because many business problems require that decisions pertaining to the relative location of features be ascertained. For example, Figure 2 illustrates how the GIS can be used to bring together and display resource locations D, F, and G and show that they are located within the boundaries of Province 6. Further, the GIS database engine is able to create a join between the attribute (tabular) data for the corresponding tables. It is therefore possible to create a query based on the spatial proximity of objects, the characteristics of the objects, or a combination of these criteria. A GIS' ability to create spatial joins gives these systems the same capabilities for summarizing and exploring data that conventional database management systems (DBMS) have except that geography serves as the primary key for linking different tables.

FIGURE 2
A JOIN BETWEEN TWO DATA SETS SHOWING THE SPATIAL RELATIONSHIP OF FEATURES



GIS Pedagogy: The View from Across Campus

Much can be learned about teaching GIS in the business school by reviewing the courses and programs in GIS that are taught in various units across a typical university campus. As noted above, geography departments are the traditional and logical home for teaching GIS. In addition, there are also a number of departments such as forestry, geology, archeology, and public planning that teach GIS in one or more courses that are core to each discipline. To understand what is typically taught in these courses, we will briefly review the courses content for two of these disciplines.

GIS in the Department of Geography

Geography programs are as diverse as business schools. Nevertheless, just as business schools have guidelines for curriculum content (e.g., those promulgated by the American Association of Collegiate Schools of Business, AACSB), so too do geography departments. The National Center for Geographic Information and Analysis (NCGIA) has proposed a model core curriculum for GIS education (see Goodchild & Kemp, 1992; http://www.ncgia.org). The model curriculum consists of more than 100 one-hour units (see Table 1). As can be seen by examining their curriculum the content represents a comprehensive list of issues that are relevant to designing, implementing, managing, and using a GIS. Further, although the curriculum includes content related to GIS applications, the bulk of the curriculum focuses primarily on technical issues related to GIS. Thus, a student seeking to become a GIS professional who is an expert in most facets of the design and use of the technology should enter a quality geography program offering this curriculum.

Of course, this does not mean that all students seeking to use GIS need to complete all of the segments of the

NCGIA core curriculum. As noted earlier, many academic departments include GIS content for their students. Much can be learned about how to integrate GIS into business courses by examining these academic units.

Public planning departments have been incorporating GIS into their curriculum for a number of years, therefore it is useful to examine how they have successfully integrated this technology.

TABLE 1
NCGIA CORE CURRICULUM CONTENT TOPIC AREAS

0. GIS Awareness

1. Fundamental Geographic Concepts for GIScience
   - 1.1. The world in spatial terms
   - 1.2. Representing the earth
   - 1.3. Position on the earth
   - 1.4. Mapping the earth
   - 1.5. Spatial relationships
   - 1.6. Abstraction and incompleteness

2. Implementing Geographic Concepts in GISystems
   - 2.1. Defining characteristics of computing technology
   - 2.2. Fundamentals of computing systems
   - 2.3. Fundamentals of information science
   - 2.4. Representing fields
   - 2.5. Representing discrete objects
   - 2.6. Representing networks
   - 2.7. Representing time and storing temporal data

3. Geographic Information Technology in Society
   - 3.1. Making it work
   - 3.2. Supplying the data
   - 3.3. The social context
   - 3.4. The industry
   - 3.5. Teaching GIS

4. Application Areas and Case Studies
   - 4.1. resource management (162)
   - 4.2. urban planning and management (163)
   - 4.3. cadastral records and LIS (164)
   - 4.4. facilities management (165)
   - 4.5. network applications (166)
   - 4.6. environmental health (169)
   - 4.7. environmental modeling (170)
   - 4.8. emergency management (172)
   - 4.9. studying and learning geography (173)
   - 4.10. business and marketing (174)
   - 4.11. recreation (176)

GIS in the Department of Public Planning

Public planning programs focus on teaching principles related to city, regional, and environmental planning and development. In many respects, the skills needed by public planners are similar to those needed by business school graduates. For example, many public planning graduates are employed by city, county, and state governments to function as managers and administrators. In this role they work within large organizations and often have supervisory or administrative responsibilities comparable to those that a business school graduate would have. Therefore planners generally need to develop skills in management, problem analysis, collaboration, decision making, computer applications, business, and economics.

How do planning departments typically integrate GIS into the curriculum? The answer is that it is similar to the way that Excel, SAS, or Access is integrated into a business school course. For example, many planning departments have one or two courses that focus exclusively on the topic of GIS and its application to the planning discipline. The content of these courses is typically quite technical, resembling the core curriculum proposed by the NCGIA. More commonly, however, GIS is integrated into extant courses such as regional planning and economics, quantitative analysis in planning, land use planning, environmental planning, or urban planning. In these courses, GIS is used as a tool to facilitate learning or to aid in the decision making or visualization process. Thus, GIS is used in a part of a course as a tool to illustrate concepts, learn new skills, or develop new insights about issues presented in the class. In this context, GIS is not the primary focus of the course, it is a means to an end. Since this is how GIS is most frequently used in business -- as a tool to help solve a problem, make a decision, or identify relationships that are not otherwise obvious -- this is how GIS should be taught in business courses.

GIS in the School of Business

What conclusions can we draw from how GIS is taught in these other disciplines? First, in most business schools there is little or no room in the curriculum for the highly technical GIS-as-a-specialty curriculum proposed by the NCGIA. Schools, which seek to obtain or maintain accreditation from organizations like the AACSB, must follow curriculum guidelines proposed by these accrediting organizations. At present, the AACSB has not promulgated guidelines that include much room for specialty courses in GIS or related technologies.

Therefore the most logical place to teach GIS in business school is in extant business school courses. In other words, business school faculty seeking to teach GIS should follow the example presented by other academic programs that have integrated GIS into their existing courses. Business courses such as marketing analysis and research, distribution and retail management, international business, introduction to computers, management information systems, decision support systems, decision analysis and problem solving, and real estate management all could benefit from the use of GIS as a teaching, analysis, and support tool. For example, GIS can easily and economically be integrated into a sophomore- or junior-level introductory computer course by using the Microsoft Excel DataMapÔ tool. DataMapÔ provides users with the ability to create maps that show the spatial distribution of data stored in an Excel spreadsheet. The DataMapÔ tool was designed to be easy to use yet provide powerful analysis capabilities (Mennecke et al., 1998).

It is in this context that this research was conducted. We integrated GIS into an existing decision support systems (DSS) course. GIS was presented to students as an example of a tool that offered data base management, decision analysis, and decision support capabilities in one software platform. In addition, other DSS topics and software such as data warehousing, group support systems, and expert systems were introduced to students in the course. Thus, GIS was presented to students as only one part of a course on the topic of decision support systems and it was presented to illustrate concepts relevant to the course.

The focus of our research is to understand how business students react to exposure to GIS technology. We focused on five areas:

1. Student perceptions of GIS effectiveness,
2. Student attitudes about the role of GIS in business courses,
3. Student attitudes about the effectiveness of GIS in helping them to understand business concepts,
4. Perceptions of the amount of understanding students had of GIS concepts, and
5. Perceptions about the impact of GIS education on helping students in their careers.

We are aware of no research that has examined these issues in a business course. Therefore, this research is exploratory in nature. However, we can form several expectations based on research in other areas. For example, prior research examining decision making shows that decision makers using GIS are more efficient and produce higher quality solutions than decision makers using paper maps (Crossland, Perkins, & Wynne, 1995). Therefore, we predict that after using GIS to complete various exercises during the semester, student perceptions related to GIS effectiveness and its role in helping them learn will be higher compared to their perceptions at the start of the semester. Furthermore, this should have a positive impact on student attitudes about the role of GIS in business courses. Unfortunately, we can make no theoretically supported predictions about students' understanding of GIS and business concepts and about GIS' impacts on careers.

RESEARCH METHOD

Student Subjects

The DSS course in which the research was conducted is a core requirement for management information systems (MIS) majors in the School of Business at East Carolina University. Students in the course were all at the junior- or senior-level and all students were majors in MIS. As such, they were familiar with a variety of software packages and programming languages. Two sections of the course were offered and examined in this research. All participants responded to a questionnaire administered by the course instructor. Participation in the survey was voluntary.

Course Content

In addition to GIS, the course covered a variety of DSS topics such as data warehousing, group support systems, and expert systems.[6] In total, students were required to complete three GIS exercises or projects. The ArcViewÔ GIS software package, a product of ESRI, Inc., was used in this course.[7] Two of the projects were small in scope while the third exercise represented a significant part of the course content. In total 7 class periods (75 minutes each) were devoted to presenting information about GIS.

Research Instrument

Part of the research instrument was administered at the beginning of the semester as a pretest before students were exposed to any content related to GIS. The pretest questions plus additional questions about the students experiences in the course were also administered to students on the last day of classes as a posttest. Thus, the research represents a one-group, pre-test, post-test design (Campbell & Stanley, 1963).

RESULTS

The descriptive statistics for the results of the study are shown in Table 2. In summary, 55 students were enrolled in two sections of the DSS course. Of this, 51 surveys were completed by students at the beginning of the semester (the pretest) and 51 were completed at the end of the semester (the posttest). Unfortunately, only 45 students completed both the pretest and posttest questionnaire. The average age of the students was 24.35 years (std dev. = 4.95), they had an average of 2.54 years of work experience (std dev. = 4.93), the average GPA was 3.0 (std dev. = 0.35), and 30% of the responders were female. All students were MIS majors. As a manipulation check we asked students to rate their experience with GIS at the beginning of the semester and at the end of the semester. The results show that students reported having significantly more experience with GIS after the course was completed (t=-10.317; p<0.001).

To examine the research questions, a paired t-test was used since participants completed the questionnaire twice. For all but one of the research questions, the results show that students had significantly more positive perceptions of GIS after their training than prior to the training. For example, GIS was thought to be significantly more effective as a decision support tool (t=4.408; p<0.001), it was more likely to be perceived to have a role in business classes (t=-2.230; p=0.031), perceptions about its role in helping students understand business concepts improved (t=2.548; p=0.014), and students had more confidence about their skills related to working with spatial data and GIS (t=-11.722; p<0.001). However, the results also show that students' perceptions about GIS' influence on their careers opportunities did not improve (t=0.976; p<0.334).

In addition to these questions, we also asked general questions about the quality of the teaching, the impact of GIS on learning, whether more time should be spent on GIS, and their overall satisfaction with being taught GIS in the course. The results suggest that students held generally favorable perceptions about GIS when the course was completed. These results are discussed in more detail in the next section.

TABLE 2
MEANS, STANDARD DEVIATION, AND PAIRED T-TEST FOR DEPENDENT MEASURES

Measure	N	Means and Statistical Parameters			
		Pretest (mean/std dev)	Posttest (mean/std dev)	Paired Sample t Statistic	P value
Perceptions of GIS effectiveness	45	2.53 (0.92)	1.80 (0.73)	4.408	<0.001***
Role of GIS in business courses	45	2.20 (1.06)	1.78 (0.85)	-2.230	0.031*
Role of GIS in understanding business concepts	45	2.51 (1.06)	2.11 (0.68)	2.548	0.014*
Student understanding of GIS concepts'	45	5.11 (1.78)	2.40 (0.72)	-11.722	<0.001***
GIS impact on a business career	46	2.61 (1.34)	2.80 (1.22)	0.976	0.334
Experience using GIS	46	6.13 (0.98)	3.85 (1.49)	-10.317	<0.001***
GIS use influenced learning	51		2.35 (1.02)		
Should more or less time be spent on GIS	51		2.92 (1.41)		
Instructor provided adequate instruction on GIS	51		2.04 (1.00)		
I am satisfied with my knowledge of GIS	51		2.18 (1.13)		

Table 2
(continued)

[1] All measures range from 1 (positive anchor) to 7 (negative anchor).
[2] This measure is the average score for the composite of three measures; " How do you feel about your ability to work with spatial data," " Rate your knowledge of geographic and cartographic principles," and " How do you feel about your ability to read and interpret tables, maps, and graphs?" The reliability coefficient for this measure is a=0.69.

DISCUSSION AND CONCLUSIONS

Our research study set out to examine the impact of teaching GIS on student perceptions about the technology. GIS is a technology that most students were expected to have little or no experience with prior to the semester. The pretest measure of student experience with the technology substantiates this expectation. This, combined with the common perception by most business people (i.e., students, faculty, and practitioners) that GIS is a tool for geographers, suggests that it is worthwhile to empirically examine the reaction of business students to this novel technology. In general, our results suggest that students developed more positive perceptions about GIS after sustained use of the technology over time.

The only exception to this is that our results also showed that students' perceptions about the impact of GIS on their careers did not improve significantly during the semester. These results were somewhat surprising given the other findings. There are several reasons why this might have happened. First of all, students held a relatively high perception about GIS' potential impact on their careers early in the semester (M=2.61). This fact, by itself, is also somewhat surprising. Since the initial instrument was administered very early in the semester before GIS had been discussed, it seems unlikely that the instructor would have had the opportunity to bias the results considerably. It is possible that the very inclusion of the topic in the course might have influenced student perceptions about its importance for their careers. It is also worth noting that the mean for this variable at the end of the semester showed a (non-significant) negative shift (M=2.80). The lack of positive outcomes associated with this variable may also have been influenced by an event that occurred during the semester. Specifically, a job fair was held approximately three weeks prior to the end of the semester. Since many of the students in this course were seniors approaching graduation, they attended the job fair and spent considerable time discussing employment opportunities with recruiters. Several students reported to the instructor their surprise that many recruiters were unaware of GIS and did not consider it important in their hiring decisions.[6] Such an event would likely have a strong negative impact on student attitudes about this issue.

Given these findings, if student perceptions about a technology have anything to do with selection of course content, then GIS appears to be a suitable technology for use in business courses. Of course this is not the only criterion for selecting course content and technological tools for inclusion in business courses. Factors such as curriculum guidelines, the relevance of the tool to employer needs and requirements, the relevance of the tool to the content and purpose of the course, and other considerations are all important. Unfortunately, because data that would address some of these factors have not yet been collected, a full assessment of the role of GIS in business courses is currently beyond our grasp. Thus, further research about the role of GIS in business is needed.

While the jury remains "out" on some of these questions, this does not imply that there is currently no reason to incorporate GIS into business courses. Regardless of what future research demonstrates about the importance of GIS in business, it is doubtful that GIS software will in the near term become as highly integrated into business courses as have statistics, database, and spreadsheet software. Nevertheless, there are good reasons to selectively and, in some cases, marginally incorporate GIS into a variety of business courses. For example, our results suggest that business students can develop positive perceptions about GIS through exposure to the technology. This should ultimately have a positive impact on learning. But these outcomes are likely moderated by the relevance of the technology to the course content and to students' likelihood to benefit from their exposure to the technology. In the case of the DSS course in which we incorporated GIS, the technology was likely perceived by students to be highly relevant because it was presented to them as a useful tool for illustrating DSS concepts. GIS would likely have little or no relevance to, for example, many finance and accounting classes, therefore it would undoubtedly not be received favorably by students. In

other courses such as, for example, retail management the visualization capabilities of GIS combined with its ability to integrate multiple data sources (e.g., information about the location of current and potential future customers), would make it very relevant and useful for illustrating concepts and ideas related to siting a new retail store. Thus, GIS is something that has the potential to improve business education if it is applied to courses thoughtfully.

An interpretation of the findings of this research is limited by the methods used and the context of the study. For example, the students in the course investigated in this research were MIS majors. Such students should be more likely to accept and appreciate new and innovative technologies than would students from other majors. For example, since MIS majors have extensive experience with a variety of software packages, their ability to learn new software would likely be superior to that of students from other majors. Many GIS packages can be quite difficult to learn when they are first used. Students possessing fewer skills and less experience with information technologies might encounter greater difficulties learning and using this type of software. This would undoubtedly lower their rating of the software. This suggests that future research should examine student populations from other majors such as marketing, management, and production. Similarly, the ArcViewÔ GIS package was used in this study. This software is one of several GIS products. Results may differ if other GIS packages were used in the course. Finally, the researcher conducting this study was also the instructor of the DSS course. Although the instructor attempted to hide the purpose of the research and to suppress highly biased comments, there is always the possibility that the instructor's interest in the topic of GIS might have influenced the results or lead to response biases. Future research replicating this line of inquiry would help to remove such concerns.

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ENDNOTES

[i] See http://www.netins.net/showcase/pab_fi66/applica.htm for information about curriculum in the public planning discipline.

[ii] An outline of the course content as presented to students in the syllabi is available from the author.

[iii] ESRI supported this research by donating licenses for the ArcViewÔ software to the instructor.

[iv] The research instrument is available from the author upon request.

[v] This is not surprising since GIS is often a "back-office" technology. In other words, it is something that is often used in one or two units in an organization and may not be widely known about in other area. Nevertheless, many well known medium and large sized employers such as Levi Strauss & Company, Sears, McDonalds, and American Isuzu Motors use GIS for a number of applications (Mennecke et al., 1998).

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